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ABSTRACT

Maintaining that two kinds of ambiguity--ambiguous prepositional phrases and ambiguous modification of conjoined elements--account for a large number of ambiguous sentences in technical writing, this paper presents an algebraic analysis of each kind of ambiguity. It then suggests a number of ways in which each ambiguity may be unclear. By using this kind of analysis, the paper offers ways for a writer to clarify ambiguities and offers rules for the use of the technical writer who discovers such ambiguities while proofreading. (TJ)

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STRATEGIES FOR REMOVING AMBIGUITY IN TECHNICAL WRITING

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I. INTRODUCTION

While textbooks agree that in technical writing it is particularly important to eliminate ambiguity, there is little systematic discussion of either the sources of ambiguity or the strategies for its removal. This paper examines only two kinds of ambiguity, ambiguous prepositional phrases and ambiguous modification of conjoined elements. These two sources of ambiguity account for forty percent of the ambiguous sentences in a corpus of twenty-five reports written near the end of a thirteen-week course in technical writing at the University of British Columbia. Unfortunately, the ad hoc sampling precludes any statistical claims, but it seems interesting that there is an average of only three ambiguous sentences per 3000-word report and that there is quite a wide range of type of ambiguity.

An ambiguous sentence is commonly defined as one that has at least two readings or interpretations. It is also usually assumed that the reader will interpret a sentence as the syntax demands. I believe, however, that in many cases, and particularly in the interpretation of structurally ambiguous sentences, this assumption is only a necessary fiction. First of all, there seems to be considerable variation among readers in the ability to recognize ambiguity, although I know of no study that measures this variation. In addition, probably as a result of repeated exposure to some errors in sentence structure, many readers seem to have acquired a considerable ability to compensate for these errors and supply a reading that the syntax does not demand. I am suggesting, then, that readers may have an error-correction grammar similar to error tolerances that are sometimes included in computer programs. Finally, and perhaps most importantly, extra-linguistic knowledge,

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such as familiarity with the subject matter, allows readers to reject some readings that the syntax may demand. In other words, even though a sentence is structurally ambiguous, it will not necessarily be perceived as ambiguous.

A particular reader, then, may respond in any one of several ways to a particular ambiguous sentence. He may, first of all, recognize only one of the two or more readings. If the recognized reading is the one intended by the writer, then there is no interference in communication. If the recognized reading isn't the one intended, and the reader accepts it, then he will misunderstand the message; this is, of course, the most undesirable result in technical communication. If, on the other hand, he rejects the reading -- and this rejection will probably depend on extralinguistic knowledge -- then he will re-read in search of an acceptable reading. Clearly, in this case, there is interference in the communication. In addition, the reader may decide that the writer is unreliable or inconsiderate, and he may transfer to the message this value judgment about the writer. His reaction, then, may be much the same as it might be to spelling errors or substandard usage. Finally, if the reader does recognize the ambiguity in the first reading, he may not have to re-read the sentence, but he will have to choose the interpretation he thinks was intended. In other words, communication will be interrupted while he makes the choice, and since the interpretation now will depend on the reader's judgment, the message may be misunderstood. As teachers, then, I think we should admit to our students that not every structurally ambiguous sentence will interfere with communication, but we should also emphasize that since we cannot predict how a particular reader will respond to a particular ambiguous sentence, we must pretend that the reader is like a computer and the written message is like a computer program. This is a particularly useful analogy in technical writing classes, because most of our students

have some experience with computer programming and realize that a computer interprets a statement in a program absolutely "literally."

In most composition courses a systematic presentation of sentence structure is almost always more pedagogically sound and more efficient than a random approach; in technical writing courses, the advantages are multiplied. Because most of our students come to us from science, the applied sciences, or commerce, they are used to approaching problems systematically and objectively and at the same time have acquired considerable sophistication in symbol manipulation. What they lack is the realization that language is a rule-governed system rather like mathematics, and a knowledge of some of the specific rules they break in their own writing. If we approach language as a system, and do so systematically, we can tap their already well-developed abilities and at the same time increase their confidence, both in us and in their own ability to control language.

The removal of ambiguities is part of the editing and revising process and consists of two major strategies, an identification strategy and a correction strategy, and both of these should be defined clearly. This of course implies a need to examine where ambiguities arise and how they can be removed.

II. AMBIGUOUS MODIFICATION OF CONJOINED ELEMENTS

The structure "Noun₁ and Noun₂" is ambiguous only if the reading "Noun₁ and Noun₂ together" is possible. For example, Mary and John owned houses can mean either that Mary and John owned houses separately, or that Mary and John together owned houses. When modifiers are attached to conjoined nouns, however, the potential for ambiguity increases:

- (1) This amount depends on the past experience and expectations of the head chef.

The critical segment of sentence (1) is past experience and expectations, which can be analyzed as:

$$\text{modifier}_1 \text{ Noun}_1 + \text{Noun}_2$$

Of course, past experience is redundant, but that is quite a separate problem. The segment is ambiguous because modifier_1 can apply only to Noun_1 , or it can apply to both Noun_1 and Noun_2 . The second reading, "past experience and past expectations," is a consequence of a generalization that can be summarized as follows:

$$\text{modifier}_1 \text{ Noun}_1 + \text{Noun}_2 = \text{modifier}_1 \text{ Noun}_1 + \text{modifier}_1 \text{ Noun}_2$$

It is not clear, then, whether the amount the writer is talking about depends on expectations the head chef had in the past or expectations he has now.

In explaining this ambiguity, we can also draw on our students' knowledge of elementary algebra and show that the two readings are analogous to the following algebraic expressions: 1) $ax + y$, 2) $a(x + y) = ax + ay$.

At least two strategies can be used to clarify sentence (1). First, we can move the unmodified noun to precede and; this yields expectations and past experience. We can summarize this strategy as follows:

$$\text{modifier}_1 \text{ Noun}_1 + \text{Noun}_2 \longrightarrow \text{Noun}_2 + \text{modifier}_1 \text{ Noun}_1$$

Our students will readily recognize that the revision is analogous to the algebraic expression $y + a(x)$. Or, if we want to describe the strategy in words, we can simply say:

Rule 1: If a pre-nominal modifier should apply to only one of the conjoined nouns, place the modified noun after and.

We can also clarify the sentence by inserting a determiner before the second noun: the past experience and the expectations. The determiner blocks the application of the first modifier across and. If the writer intends the reading the above strategies have removed, he can reverse the order of the

nouns to yield past expectations and experience. This revised segment is not ambiguous because the two readings, "past expectations and experience" and "past expectations and past experience," are essentially synonymous. In the general case, however, if only the reading "modifier₁Noun₁ and modifier₁Noun₂" is intended, the second occurrence of modifier₁ cannot be omitted. In other words, the segment would have to be past experience and past expectations.

If, on the other hand, a modifier follows a conjoined noun, the problem presented by sentence (1) is reversed:

- (2) Employee appraisals should be given semiannually to keep the manager aware of problem areas and employees that are not doing their jobs effectively.

The critical segment in sentence (2) is: problem areas and employees that are not doing their jobs effectively. As we saw in the discussion of sentence (1), problem applies across the conjunction; we will return to the entire structure later, but for now let us pretend that problem is not there. The segment that remains can now be analyzed as:

$$\text{Noun}_1 + \text{Noun}_2\text{modifier}_2$$

This segment is again ambiguous because in addition to modifier₂ applying only to Noun₂, it can also apply to both Noun₁ and Noun₂. The second reading, "areas that are not doing their jobs effectively and employees that are not doing their jobs effectively," results from the following generalization:

$$\text{Noun}_1 + \text{Noun}_2\text{modifier}_2 = \text{Noun}_1\text{modifier}_2 + \text{Noun}_2\text{modifier}_2$$

Again, the readings of this ambiguous segment in sentence (2) are analogous to the following algebraic expressions: 1) $x + ya$, 2) $(x + y)a$.

To preclude the second, presumably unwanted, reading of sentence (2), we can apply a strategy that is the reverse of Rule 1:

$$\text{Noun}_1 + \text{Noun}_2\text{modifier}_2 \longrightarrow \text{Noun}_2\text{modifier}_2 + \text{Noun}_1$$

The result is now analogous to the algebraic expression $y(a) + x$. We can describe the strategy in the following words:

Rule 2: If a post-nominal modifier should apply to only one of the conjoined nouns, place the modified noun before and.

If only the second reading is intended, however, then modifier_2 will have to be used twice, once with each of the conjoined nouns.

If we now return to the complete critical segment in sentence (2), we see that when problem is added, the segment can be described algebraically as: 1) $ax + yb$, 2) $a(x + yb)$, 3) $(ax + y)b$, 4) $a((x + y)b)$, 5) $(a(x + y))b$. Since the last two expressions are equivalent, both being $axb + ayb$, the segment has four readings. It is likely, however, that the reading with the algebraic equivalent of $ax + yb$ is the one intended. Although the result is by no means elegant, we can isolate this reading by applying either Rule 1 or Rule 2:

- (2a) Employee appraisals should be given semiannually to keep the manager aware of employees that are not doing their jobs effectively and problem areas.

It is obvious, I think, that as the number of modifiers increases, there is danger of a sentence becoming multiply ambiguous:

- (3) It consists essentially of a circular rack holding the receiving tubes and a photoelectric counter to count the number of drops emerging from the column.

When the rules I have stated cannot be applied easily, I advise students to make separate clauses or sentences of the noun-modifier groups. In other words, circular rack holding the receiving tubes can be restated as The circular rack holds the receiving tubes, and a photoelectric counter to count the number ..., can be restated as A photoelectric counter counts the number... Sentence (3), then, could be revised as follows:

- (3a) It consists essentially of a circular rack and a photoelectric counter. The rack holds the receiving tubes; the photoelectric counter counts the number of drops emerging from the column.

If some students cannot make these conversions from surface structure modifiers to underlying strings, we should demonstrate, in simplified terms, the changes required.

Much the same problems as those posed by conjoined modified nouns arise when modified modifiers are conjoined:

- (4) Zinc-chloride cells were considered the most promising because they are nearest to being commercially available and relatively inexpensive.

Are zinc-chloride cells "relatively inexpensive" or "nearest to being relatively inexpensive"? We can now extend our original rules as follows:

Rule 1a: If a left-most modifier should apply to only one of the conjoined elements, place the modified element after and.

Rule 2a: If a right-most modifier should apply to only one of the conjoined elements, place the modifier element before and.

A special problem is presented by negation, as in sentence (5):

- (5) Do not tack the beginning or end threads and leave about 2 inches of end thread.

Because the domain of the negative is not clear, we do not know whether or not one should "leave about 2 inches of end thread." If we consider this negative as a left-most modifier, then we can apply Rule 1a to sentence (5):

- (5a) Leave about 2 inches of end thread and do not tack the beginning or end threads.

III. AMBIGUOUS PREPOSITIONAL PHRASES

About thirty percent of the sentences in my corpus are ambiguous because they contain prepositional phrases that can be either adverbial or adjectival. Usually, the writer seems to have intended the phrase to be adverbial, but the placement of the phrase immediately after a noun invites an adjectival

reading as well.

Half of the ambiguous prepositional phrases in my corpus are with-phrases. This may be because, as we shall see, a with-phrase can perform a variety of functions and therefore can have several potential readings.

The instrumental with is particularly prone to ambiguous placement. The problem is illustrated in the following example: He injured the man with the knife. Clearly, this sentence has the readings: 1) "He used the knife to injure the man," and 2) "He injured the man who has the knife." The first reading is a paraphrase of the instrumental function of the with-phrase, and the second reading is a paraphrase of the attributive function of the with-phrase. The ambiguous structure can be analyzed as:

$\text{Noun}_1 + \text{Verb} + \text{Noun}_2 + \text{with Noun}_3$

It will be ambiguous if both the verb and the with-phrase are compatible, and Noun_2 and the with-phrase are compatible.

In my corpus, the kind of ambiguity described above is seen in sentence (6):

(6) She should mark off the fold line with pins.

At least two strategies are available for removing this ambiguity. First, instrumentality can be expressed with use:

(6a) She should use pins to mark off the fold line.

This strategy can be generalized in the following statement:

$\text{Noun}_1 + \text{Verb} + \text{Noun}_2 + \text{with Noun}_3 \longrightarrow$

$\text{Noun}_1 + \text{use} + \text{Noun}_3 + \text{to} + \text{Verb} + \text{Noun}_2$

Second, the noun and with-phrase can be separated, and the adjectival reading removed, by making the sentence passive:

(6b) The fold line should be marked off with pins by her.

This change from sentence (6) to sentence (6b) is generalized in the following statement:

$$\begin{array}{l} \text{Noun}_1 + \text{Verb} + \text{Noun}_2 + \text{with Noun}_3 \longrightarrow \\ \text{Noun}_2 + \text{be} + \text{Verb} + \text{with Noun}_3 + \text{by Noun}_1 \end{array}$$

If, as in sentence (6), the agent, the subject of the active sentence, is not particularly important, it can be deleted in the passive. The following statement generalizes this strategy:

$$\begin{array}{l} \text{Noun}_1 + \text{Verb} + \text{Noun}_2 + \text{with Noun}_3 \longrightarrow \\ \text{Noun}_2 + \text{be} + \text{Verb} + \text{with Noun}_3 \end{array}$$

Applying this to sentence (6), we get (6c):

(6c) The fold line should be marked off with pins.

A less desirable strategy, if the agent cannot be deleted, is summarized in the following statement:

$$\begin{array}{l} \text{Noun}_1 + \text{Verb} + \text{Noun}_2 + \text{with Noun}_3 \longrightarrow \\ \text{Noun}_2 + \text{be} + \text{Verb} + \text{by Noun}_1 + \text{with Noun}_3 \end{array}$$

Applying this to sentence (6), we get the unambiguous, but rather awkward (6d):

(6d) The fold line should be marked off by her with pins.

If, however, instead of being a pronoun, the agent is a noun, such as the man, then we cannot apply this strategy because the collocation of this noun and the with-phrase would create an ambiguity like the one we were trying to remove.

The hazard of the with-phrase in a passive clause is further illustrated in sentence (7):

(7) It is the purpose of this report to outline a procedure for making thin-sections which can be used by students with the minimum of supervision.

The problem here, of course, is that the with-phrase can modify either can be used or students. We can remove this ambiguity by making the clause active:

(7a) ... which students can use with the minimum of supervision.

Then, if the with-phrase really should modify students, we can also have (7b):

(7b) ... which students with the minimum of supervision can use.

We will not discuss here the ambiguity of the relative clause.

Another kind of ambiguous with-phrase is seen in sentence (8):

(8) This would provide more courtroom space with minor renovations.

This with-phrase can have either an attributive adjectival reading, "space with minor renovations," or a causal reading, "minor renovations cause more courtroom space." Raising minor renovations to subject status isolates the causal reading:

(8a) In this way, minor renovations would provide more courtroom space.

Unfortunately, this correction strategy is not easy to generalize.

Students also tend to use with-phrases where other prepositional phrases or other relational indicators might be more appropriate:

(9) As a result, there is now a group of boards all two inches thick with varying lengths and widths resting on the trimmer bed.

(10) The card is run through a charge card printer with a form.

Another category of ambiguous prepositional phrases can be illustrated with the following example: He wrote the book in the kitchen. Clearly, this sentence has the readings: 1) "It was in the kitchen that he wrote the book." and 2) "He wrote the book which is in the kitchen." The ambiguous structure can be analyzed as:

Noun₁ + Verb + Noun₂ + Prep. Noun₃

Again, it will be ambiguous if both the verb and the prepositional phrase are compatible, and Noun₂ and the prepositional phrase are compatible. In other words, the sentence will be ambiguous if the prepositional phrase can be both adverbial and adjectival.

In my corpus, this kind of ambiguity is illustrated in the following sentences:

- (11) Adjust the zipper foot to the right of the needle.
- (12) At this stage it is necessary to observe the optical properties of the rock under the microscope in order to determine how close to being finished the thin-section is.
- (13) The main purpose of the offbearer is to pull lumber that is marked for his station off the greenchain.
- (14) For liquids, the appropriate size of bottle is used and the label is fixed on the round side of the bottle at the top.

In each case, the adverbial reading of the underlined prepositional phrase is probably intended, but the placement of this phrase immediately after a noun with which it may be compatible allows an unwanted locative reading. If this locative reading is intended, then the relative clause from which it is derived should be recovered. In other words, we should make the following change:

Noun₂ + Prep. Noun₃ $\longrightarrow$ Noun₂ + which + is + Prep. Noun₃

Applying this strategy to sentence (11) produces sentence (11a):

- (11a) Adjust the zipper foot, which is to the right of the needle.

To exclude this reading, on the other hand, we have to use different strategies. Sentence (11) can be made passive to separate the noun and the prepositional phrase:

- (11b) The zipper foot should be adjusted to the right of the needle.

The locative readings in sentences (12), (13), and (14) can be excluded by moving the prepositional phrases to follow immediately after the verbs:

- (12a) ... observe under the microscope the optical properties ...
- (13a) ... pull off the greenchain the lumber ...
- (14a) ... fixed at the top on the round side ...

IV. CONCLUSION

When proofreading for ambiguities, students should focus on those structures that are most likely to be ambiguous. This implies, of course, that they must know where to look and what to look for. This paper has suggested that they should check the neighbourhood of each and to be certain that the extensions of modifiers are not ambiguous, and that they should check each collocation of a noun and a prepositional phrase to be certain that the potential adjectival reading is intended. After they have identified an ambiguity, students need to know how to remove it. The strategies suggested in this paper can be followed to remove the two main kinds of ambiguities examined. Obviously, other strategies will have to be used to remove other kinds of ambiguities. Students must also realize, however, that no set of rules can be applied blindly, for a great many relationships may be expressed in a sentence, and solving one problem may create another.